Cypriot Intangible Cultural Heritage
DIGITIZING FOLK DANCES

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Cyprus has a long and rich history of dance tradition which unfortunately, year after year, tends to be forgotten; thus, it is our duty to help documenting and disseminating our dance heritage to the younger generations. In this work, we aim to preserve the Cypriot folk dance heritage, creating a state-of-the-art publicly accessible digital archive of folk dances. Our dance library, apart from the rare video materials that are commonly used to document dance performances, utilises three dimensional motion capture technologies to record and archive high quality motion data of expert dancers.

Introduction

Cyprus has a rich history of over 10,000 years and a cultural heritage which, due to its location between three continents, has been influenced by various civilizations. Many academic and industrial organisations took advantages of the recent technological advances in Information and Communication Technologies, and have attempted to record, curate, remediate and preserve mostly the tangible part of the Cypriot cultural heritage. However, Cypriot cultural heritage also encompasses a range of important intangible assets (e.g., folk dances, traditions, the art of pottery). According to the 2003 Convention for the Safeguarding of the Intangible Cultural Heritage (ICH)[1], ICH is the mainspring of humanity's cultural diversity and its maintenance is a guarantee for continuing creativity. ICH creations are transmitted orally or by gestures and they are modified over time through the process of collective recreation, and/or changes in the way of life over the years. Thus, it is necessary to document and disseminate these intangible assets of the Cypriot heritage in order to preserve them and pass them over to the younger generations.

Performing arts and especially folk dancing is an important part of the cultural heritage of the island. Folk dancing cannot be easily preserved and its dissemination to the younger generations has become challenging for the few cultural institutions offering lessons; the Cypriot folk dance heritage is primarily transmitted by dance teachers and some of the senior citizens, as well as rare video recordings from local festivals, weddings and other social gatherings. In the Computer Graphics and Virtual Reality Lab[2] (VRL), we aim to develop the first high quality digital archive, in collaboration with local cultural institutions; our intention is to digitize, record, and archive the Cypriot folk dance heritage, as well as to disseminate it to the wider local community and serve as a reference for related research activities. The Cypriot folk dances have never been before systematically recorded and archived using motion capture technologies. Currently, two dimensional video recordings are used to document traditional Cypriot dance performances, which however have many limitations, such as occlusions or a fixed 2D camera viewpoint. VRL uses advanced 3D motion capture technologies to digitize Cypriot folk dances free of most limitations associated with traditional 2D video recording. In collaboration with expert performers from local cultural institutions Cypriot folk dances are digitally captured and stored. This high quality data can be subsequently used for reproduction, analysis, documentation, as well as research.

Related Work

Over the last decade, many works aimed at capturing the tangible part of the Cypriot cultural heritage; for instance, Sofocleous et al. [1] have documented the Asinou church, a Byzantine painted church dedicated to the Virgin Mary. The authors created a three dimensional visualization of the monuments in a virtual world, combining various photogrammetric procedures. Agapiou et al. [2] designed a web-based environment with a Monument Information Database that concerns the ten painted Byzantine Churches of Cyprus that are listed in the UNESCO World Heritage List (WHL), while Bariami et al. [3] proposed a method for geometric documentation of Cypriot monuments of the UNESCO WHL using complementary techniques. Zányi et al. [4] presented a computer reconstruction method that simulates modern lighting and the candle light of Byzantine art for better representation of the atmosphere and environment of the

1. UNESCO, http://www.unesco.org/

2. VRL Lab, http://graphics.cs.ucy.ac.cy

buildings and paintings in Byzantine times. Ioannides et al. [5] [6] presented various methodologies for digitally capturing and documenting ancient monuments, including buildings, sites and pottery.

However, very few have been working on documenting or digitising the intangible part. Stavrakis et al. [7] presented an early version of the digital dance library at VRL. An interactive game for teaching dances using low cost depth motion capture systems (such as Microsoft Kinect system) has also been designed for dissemination. However, in order to have an efficient and more complete system, further motion capture sessions are required to enrich the database. This can be both time consuming and tedious since raw motion captured performances have to usually be post-processed in order to eliminate any unrealistic and unnatural poses occurring during the digitization process.

Motion Capture Technology

Optical motion capture is a technology used for turning the observations of a moving subject into 3D position and orientation information about that subject. Motion capture devices allow the recording of live motions by tracking a number of key points in space over time, which are translated into a 3D digital representation. The captured subject can be a moving object (such as a legged character), with the key points positioned on the object such that they best represent the orientations of its moving parts. This data can be used for reconstruction of the performer's skeleton, tracking and modelling of the motion. Motion capture data is extensively utilized in computer-generated characters often seen in television commercials to promote products, movie productions, such as Avatar, The Lord of the Rings, etc. and many 3D computer games.

The VRL lab has been recently equipped with a new motion capture system (the latest Phasespace[3] Impulse X2 motion capture system with active LEDs) and a 3-wall immersive virtual reality set-up. The system uses 8 cameras that are able to capture 3D motion using modulated LEDs. These cameras contain a pair of linear scanner arrays operating at high frequency each of which can capture the position of any number of bright spots of light as generated by the LEDs. It offers a fast rate of capture (960Hz) and allows the individual markers to be identified by combining the information from several frames and hence identifying the marker from its unique modulation. The markers are placed at strategic points on the articulated body (i.e., of a performer) so that these points can be easily and accurately located by the cameras and to provide the rotation of each limb segment. The subject can then move freely within a specified space (the capture volume) while the markers attached to its body are tracked over time and used to reconstruct a complete three-dimensional pose of the subject's body, at any point in time. Our system is able to capture 3D motion data of a single character over time, maintaining the correct human proportions and the naturalness of the action. The mobility of our motion capture system, its wireless structure and advanced software, enables motion capture sessions to be performed in external, non-laboratory environments. Figure 3.1 shows a dancer wearing the motion capture suit, where its movements are captured using the PhaseSpace Impulse X2 motion capture system.

Figure 3.1 A dancer wearing a motion capture suit at VRL, where its movements are captured using the PhaseSpace Impulse X2 motion capture system.

3. Phasespace Inc: http://www.phasespace.com

Motion Capture Digital Dance Library

We aim to create a point-of-reference publicly accessible digital archive of folk dances using 3D motion capture data (with metadata). In order to ensure that Cypriot folk dances are sufficiently well documented, recorded and archived, dance performances should be captured directly from expert dancers using motion capture technology. The archive will give free access to 3D motion capture (mocap) data, video data, photographs, drawings, text and metadata. It is important to note that capturing a dancer's performance does not mean capturing of the dance itself; the quality characteristics of human behaviour and dance motion are subjective and depend on, in addition to the dancer's skill and experience, momentary feelings, the external environment etc. For this reason, we have tried to reduce the potential influence of external factors that affect the quality of the motion during the capturing procedure. For instance:

- The mocap suit has markers attached on every limb which for some performers may feel uncomfortable or restricted at first. To mitigate this problem we allow performers to first "warm-up" and experiment with the wide range of motion the mocap suit allows, prior to any actual motion capture session.
- The size of the laboratory restricts the movements of the performer to a limited space; in addition, the feeling of laboratory environment reduces the user's intimacy with the area, thus limiting his creativity. This can be solved by capturing in environments which are familiar to the dancer, such as dance schools and/or local festivals.

In order to facilitate the long term maintenance, we designed an archive that can easily be enriched with new data over time. We have employed a relational database schema to structure the information within the archive, which encompass all types of data associated with dances. The archive is scalable, so that data and metadata, such as motion capture and video data can be accumulated as they become available. It also provides for archiving existing material irrespective of the availability of motion capture or video data. The relational database forms the backend of the archive, while an online web portal enables public access to the data of the archive, as well as editing capability to privileged users.

Currently there is no standardised method of dance recording and archiving and there are several on-going efforts, e.g. that of the Dance Heritage Coalition[4]. We are keen to develop a simple schema that can be readily used to record those aspects of the motion captured dances which will allow us to disseminate the data to the wider research and performing arts communities. Nevertheless, the dance database is planned to be organised according to ACMI (actions' creativity metadata interface) regulations, aiming to be compatible with EUROPEANA[5] (the EU library) initiatives, and therefore available for further re-use. It is thus very important to capture the human motion itself, directly from expert dancers, allowing the reuse, study or teaching of the, usually structured or complex, motion..

Our digital archive supports data types that are already available, as well as those we aim to produce. This includes textual descriptions about dance types, video recordings and motion capture data of individual performances, metadata of dancers appearing in performances and the locations these dances are performed. The schema of the database used to structure the different information about Cypriot folk dances consists of 6 main categories:

- dances - each entry of this category is a unique dance plus the accompanying metadata, which include the name of the dance, the type of dance, photos, the region it originates from and a description.
- performers - each entry describes a unique performer. Fields of the table include the name and age of the performer, his/her gender, the years of experience, and whether is a professional or amateur performer.
- locations - each entry is the place that the data have been captured. Typically these locations have a name, address, a contact and the name of an administrator.
- videos - each of the video data entries is a video recording of a dance performance. The video data has a timestamp to record the date the video was captured, the filename of the actual video, the

4. Dance Heritage Coalition: http://www.danceheritage.org/

5. Europeana: http://www.europeana.eu/

format and an arbitrary description.

- mocaps - each entry is a description of the motion capture data of a unique dance performance. The motion capture data has a timestamp field to record the time it was captured, a filename pointing to the actual motion data and a description field to hold generic information. The mocap data will be available in the widely used C3D, FBX, and BVH motion data formats.
- performances - is the central table of the schema. Each entry is a unique performance of a dance and has a timestamp field and a description of the performance. The rest of its fields contain indices of entries in other tables which enables creating one-to-many relations for a single performance. A performance entry is a unique manifestation of a dance type and thus the dance index is stored in a performance's field to relate them. Each performance may be related to multiple performers, which is necessary for dances with groups of performers. A performance takes place at a single location, but the venue may be reused for multiple performances, therefore each performance records where it has taken place. Similarly, a list of video and a list of motion capture data indices are stored to relate a performance with the relevant data. Note however, that there may be more than one dataset for each type. For instance, when multiple cameras are used, a performance will have multiple video data files associated with it.

Our dance library aims to store high quality motion capture data; in order to be more specific, we store the following digital data:

- **Video:** Dance recording using an HD camera. Data are stored in AVI (compressed using the Xvid MPEG-4 codec) or FLV (flash) formats, as shown in Figure 3.2(a). The user has the opportunity to download standard quality and/or high quality video to check whether the performance is the desired and meets the specifications of his work, before downloading the motion files, that are in general much larger in size.
- **Mocap data:** the standard motion capture format (C3D) that stores 3D coordinate information, analogue data and associated information used in 3D motion data capture and subsequent analysis operations, as shown in Figure 3.2(b). The C3D file format is a public domain, binary file format and it is adopted by all major 3D motion capture companies. All the required information can be seamlessly transferred between researchers and laboratories, regardless of the hardware or environment used to collect the data. In addition, the user has the opportunity to create his own motion file (such as BVH or FBX) and to apply post-processing techniques on the provided raw data in order to correct the position of missing markers or to use them for studying or researching purposes.
- **Motion file:** the motion of the performer is saved as a BVH format, as shown in Figure 3.2(c). BVH stands for Biovision Hierarchical Data; this format is mainly used as a standard representation of movements in the animation of humanoid structures. It consists of two parts where the first section details the hierarchy and initial pose of the skeleton and the second section that contains the motion data, which provides per frame positions and orientations of joints and limbs.. It is currently one of the most popular motion data formats, and has been widely adopted by the animation community. Any 3D virtual character (avatar) fitting the skeletal structure in a motion file can thereafter perform the motion by using the stored motion data.
- **Character data:** A virtual character (avatar) with mesh has been incorporated to the motion file (this format will not be always available), as shown in Figure 3.2(d); FBX format is now owned by Autodesk. It is used to provide interoperability between digital content creation applications. It maintains the full fidelity and functionality of the original file and can be manipulated by multiple programs; it is used for creating interoperability between 3D applications.
- **Web interface:** A 3D web application based on the Unity3D[6] engine is provided to allow users to view

6. UNITY 3D: http://unity3d.com/

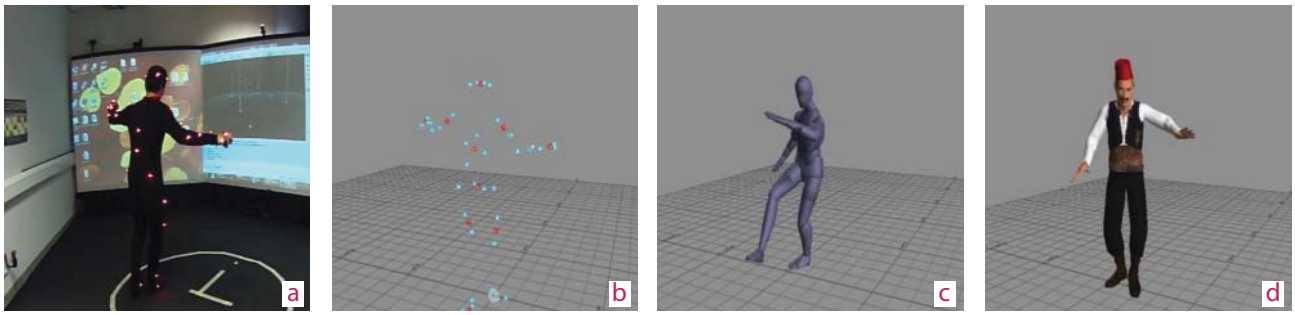

Figure 3.2 (a) the video format, (b)the mocap format, (c) the motion file format and (d) the character format.

the motion capture data online or preview before downloading them.

A prototype dance digital library has already been implemented at the UCY, storing mocap data of folk dances. The dance library is publicly accessible via the WWW, at: http://dancedb.cs.ucy.ac.cy/ [8].

Conclusions and Future Work

In this work we have paved the way for documenting Cypriot folk dance performances, using 3D motion capture technology, aiming to create a reference digital dance library, supplemented with standard text, drawings, pictures and video. The motion capture dance library aims to document the Cypriot dance cultural heritage, particularly for traditional dances that tend to be neglected or forgotten. Using motion capture technologies, not only are we setting an example for safeguarding the survival of these important intangible assets objectively, but also enable the reuse, study and teaching of these structured and complex motions. The high quality motion capture data that are archived in our database can find several applications, including academic (for research purposes) and industrial (in the film and game industry).

In the near future, the database will be enriched with various solo or group dance performances and it will be constructed and notated for further research activities. Next step is the qualitative and quantitative, as well as the semantic representation of Cypriot folk dances for efficient motion retrieval. The library will be indexed and notated using high level components, based on the characteristics of the dance motion. A search by example engine will be incorporated that will return dances that comprise similar movements to a given action. The system will also be able to log a movement, interpret it and find whether it is contained within a dance performance.

In addition, we aim to develop and distribute a game that uses low cost depth sensors, such as Microsoft's Kinect, exclusively for teaching Cypriot folk dances, as a means of promoting and preserving the local folk dance heritage. The game will feature the 3D avatar of a Cypriot dance teacher dressed with the traditional costume. The virtual teacher will support a range of pre-captured dances performed by experienced local folk dancers. The user will select the dance he/she would like to learn from the motion capture database and the virtual dancer will demonstrate the motion to the user. Thereafter, the user will be asked to perform alongside the virtual teacher; the motion will be captured in real-time via a low cost depth sensor (ideal for home users) and will be attached to a second virtual avatar, so that the user has visual feedback of his movements. A motion matching algorithm will be implemented to compare the movements based not only on posture matching (meaning the physical position of the avatar) but also on the quantitative and qualitative characteristics of the motion (LMA entities), the required effort, the emotional state, as well as the relevance to the performer's intention. A feedback system that will provide hints and advice to the end-user with regards to his performance, indicating parts of the dance that would require more practice and attention by the user.

The proposed dance database could also be utilised for dance similarity comparisons, helping to unveil cultural similarities between neighbouring countries (dance ethnography).

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